



Docket No.: 207224US0

COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313



ATTORNEYS AT LAW

RE: Application Serial No.: 09/846,255
Applicants: Satoshi KIKUCHI, et al.
Filing Date: May 2, 2001
For: CLEANING PROCESS FOR SUBSTRATE SURFACE
Group Art Unit: 2813
Examiner: L. Schillinger

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SIR:

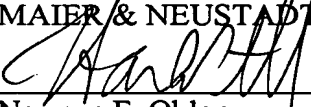
Attached hereto for filing are the following papers:

APPEAL BRIEF W/APPENDIX (IN TRIPLICATE)

Our credit card payment form in the amount of \$330.00 is attached covering any required fees. In the event any variance exists between the amount enclosed and the Patent Office charges for filing the above-noted documents, including any fees required under 37 C.F.R. 1.136 for any necessary Extension of Time to make the filing of the attached documents timely, please charge or credit the difference to our Deposit Account No. 15-0030. Further, if these papers are not considered timely filed, then a petition is hereby made under 37 C.F.R. 1.136 for the necessary extension of time. A duplicate copy of this sheet is enclosed.

Respectfully submitted,

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DOCKET NO: 207224US0

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF :

SATOSHI KIKUCHI, ET AL. :

SERIAL NO: 09/846,255 :

FILED: MAY 2, 2001 :

FOR: CLEANING PROCESS FOR
SUBSTRATE SURFACE :

EXAMINER: SCHILLINGER, L.

GROUP ART UNIT: 2813

APPEAL BRIEF

COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313

SIR:

This is an appeal of the Rejection dated June 25, 2003 of twice-rejected Claims 1-3 and 5-14. A Notice of Appeal was filed September 25, 2003.

I. REAL PARTY IN INTEREST

The real party in interest in this appeal is m • FSI Ltd. having an address at c/o Kyohan-Kudan Building 5-10, Iidabashi 1-chome, Chiyoda-ku, Tokyo 102-0072, Japan.

II. RELATED APPEALS AND INTERFERENCES

Appellants, Appellants' legal representative and the assignee are aware of no appeals or interferences which will directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

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III. STATUS OF THE CLAIMS

Claims 1-3 and 5-14, all the claims in the application, stand rejected and are herein appealed.

IV. STATUS OF THE AMENDMENTS

No amendment under 37 CFR 1.116 has been filed.

V. SUMMARY OF THE INVENTION

As recited in Claim 1, the invention is a process for cleaning a surface of a substrate, said surface carrying thereon a high-density film and a low-density film lower in density than said high-density film in combination, which comprises continuously bringing a mixed gas comprising anhydrous hydrogen fluoride gas and a heated inert gas into contact with said surface of said substrate such that at least a portion of said low-density film is removed without impairing said high-density film beyond a tolerance, wherein the mixed gas does not contain steam.

See the specification at page 10, lines 3-12 and page 13, line 19ff.

VI. ISSUES

Whether Claims 1-3 and 5-14 are unpatentable under 35 U.S.C. §103(a) over U.S. 5,635,102 (Mehta) “as applied to claim 1 above, and further” in view of U.S. 5,922,624 (Verhaverbeke et al)?¹

VII. GROUPING OF THE CLAIMS

The dependent claims each stand or fall separately from Claim 1.

¹ There does not appear to be a separate rejection of Claim 1 only.

VIII. ARGUMENT

Claims 1-3 and 5-14 stand rejected under 35 U.S.C. §103(a) as unpatentable over Mehta in view of Verhaverbeke et al. That rejection is untenable and should not be sustained.

As recited in Claim 1, the present invention is a process for cleaning a surface of a substrate, said surface carrying thereon a high-density film and a low-density film lower in density than said high-density film in combination, which comprises continuously bringing a mixed gas comprising anhydrous hydrogen fluoride gas and a heated inert gas into contact with said surface of said substrate such that at least a portion of said low-density film is removed without impairing said high-density film beyond a tolerance, wherein the mixed gas does not contain steam.

As an example, the present invention was able to be achieved by continuously feeding, at a flow rate of 40-60 L/min, an anhydrous hydrogen fluoride gas accompanied by an inert gas heated at 50-100°C, in a pre-warmed treatment chamber. Such continuous feeding produces a continuous steam of the mixed gas on the surface of the substrate, which stream plays an important part in controlling water amounts on the substrate and in the chamber. The stream itself acts as a controller of water amounts; the anhydrous hydrogen fluoride itself acts as a controller of water amounts due to its strong affinity with water.

Mehta is from the same patent family as JP 8-319,200 A, which is described in the specification at page 5, lines 18-22; page 6, line 15, through page 8, line 14; page 21, lines 8-11; and page 22, line 23, through page 23, line 6. Mehta discloses a process for selectively removing a porous silicon oxide layer from a substrate having a portion thereon with an exposed dense silicon oxide to be retained on the substrate, the porous silicon oxide layer containing absorbed moisture therein, the process comprising introducing the substrate to a flowing anhydrous gaseous environment consisting of anhydrous inert gas, adding anhydrous

hydrogen fluoride gas to the gaseous environment for a pulse time which is at most only shortly longer than that required to initiate etching of the dense silicon oxide, flushing the gaseous environment with anhydrous inert gas for a time sufficient to remove the hydrogen fluoride and water vapor generated by the etching of the porous oxide, and repeating the adding and flushing steps until the porous oxide layer has been removed (abstract). Thus, in Mehta, the anhydrous hydrogen fluoride gas does not flow continuously, as required by the present invention, but in pulses. As an example, Mehta discloses the use of 2 to 9 pulses between about 3 and 8 seconds each, preceded and interspersed by flush cycles of up to 60 seconds each (column 4, lines 39-42). There is no disclosure or suggestion in Mehta to flow the anhydrous hydrogen fluoride gas therein continuously.

Recognizing that Mehta does not disclose or suggest continuous application of the presently-recited mixed gas, the Examiner relies on Verhaverbeke et al.

Verhaverbeke et al is drawn to the etching of SiO₂ layers by HF vapor etching. Verhaverbeke et al disclose that traditionally, HF vapor etching is performed with a mixture of HF and H₂O vapors at near atmospheric pressures in a mode where the process gases are continuous flowing, the so-called dynamic mode, but because of controllability problems with this process, it has been improved by performing it at substantially reduced pressures, and applying a different procedure, the so-called static mode; despite these improvements, the controllability of the process is still problematic (column 2, lines 1-11). The invention of Verhaverbeke et al is an improvement over this prior art, and involves the use of gaseous mixtures of hydrogen fluoride and one or more carboxylic acids, with or without the addition of water (column 4, lines 5-9). Verhaverbeke et al describe results for the static etch mode (column 5, lines 6ff), and the one example therein appears to be carried out in a static mode, according to Verhaverbeke et al's definition of static mode at column 3, lines 22-25 and in Claim 11. Indeed, the only disclosure about a dynamic mode for the invention therein is in

Claim 12. Thus, it is inferred that the static mode is the preferred mode in Verhaverbeke et al. At column 5, line 27ff, Verhaverbeke et al disclose that their inventive gaseous mixtures etch at different rates depending on the type of silicon oxide film etched. Silicon oxide films formed by chemical vapor deposition, such as by thermal decomposition of tetra ethyl ortho silicate (TEOS), typically have a higher etch rate compared to silicon oxide formed by thermal oxidation of silicon, although densification of the TEOS-formed silicon oxide film reduces the etch rate, and that in general, it is preferred that the selectivity, i.e., the ratio of the etch rate of the TEOS-formed film to the thermal oxidation-formed film, be close to 1. In other words, Verhaverbeke et al recognizes different etch rates for different types of silicon oxide films, but prefers a selectivity of 1, i.e., no difference in etch rates.

It is not clear why one skilled in the art would combine Mehta and Verhaverbeke et al. Mehta is concerned with selectively removing a porous silicon oxide layer from a substrate having a portion thereon with an exposed dense silicon oxide to be retained on the substrate, and involves the use of anhydrous hydrogen fluoride. Verhaverbeke et al., on the other hand, although they recognize different etch rates for different silicon oxide layers, is not concerned with removal with **ultimate selectivity** of one out of two silicon oxide layers, and while anhydrous hydrogen fluoride may be used, water may also be included. In addition, Verhaverbeke et al do not disclose any advantage from using a dynamic mode in place of a static mode. Indeed, in the disclosure of Verhaverbeke et al relied on by the Examiner, i.e., column 2, lines 1-15, the static mode was intended to be an improvement over the dynamic mode. If anything, this disclosure teaches away from replacing the pulse treatment of Mehta with a continuous treatment. Moreover, if a proposed modification would render a prior art invention unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 221 USPQ 1125 (Fed. Cir. 1984). See also MPEP 2143.01.

Moreover, the Examiner's rationale presupposes that one skilled in the art would ignore differences in treatment compositions when substituting different treatment schemes, i.e., continuous, pulse, dynamic, static, for each other. There is no evidence in the record to support this presupposition. As discussed above, Mehta's and Verhaverbeke et al's treatment compositions are different.

Moreover, if it were obvious to change Mehta's pulse treatment to a continuous treatment, it is surprising that Mehta did not disclose a continuous treatment, since a continuous treatment is much simpler as a treatment process and much superior in running costs than the pulse treatment therein, and a person skilled in the art would generally prefer a continuous process and try one in the first instance. The only reasonable conclusion therefrom is that Mehta could not achieve satisfactory results using a continuous treatment.

See also the Examples and Comparative Examples in the specification herein, and particularly Comparative Example 3, which is analogous to the pulse treatment of Mehta. As Appellants describe in the specification at page 45, lines 16-23:

It has, however, been found that under the conditions of this Comparative Example, complete removal of water formed on the surface is difficult basically and the degree of selective removal of the film is inferior to those achieved in the Examples. Further, compared with Example 1, Comparative Example 3 requires considerably longer dipping time and is also inferior in economy.

In the present Office Action, the Examiner, in essence, ignores the fact that Verhaverbeke et al's disclosure of interchangeability of static and dynamic mode is with regard to Verhaverbeke et al's mixture of gases comprising hydrogen fluoride and at least one carboxylic acid. Verhaverbeke et al disclose and suggest nothing with regard to anhydrous hydrogen fluoride gas etching containing no carboxylic acid, and especially such etching in the absence of steam, as required by the claims.

Nor has the Examiner established that one skilled in the art would equate the pulse mode of Mehta with the static mode of Verhaverbeke et al. Verhaverbeke et al disclose a static mode as simply filling the reactor with a process gas up to a certain pressure and then the reactor is isolated for some time; subsequently the reactor is evacuated and the etch cycle can be repeated a number of times (column 3, lines 22-25). In the Example of Verhaverbeke et al, the isolation time is 200 seconds. Appellants submit that one skilled in the art would hardly equate this scheme with the pulse mode of Mehta.

Nor does the Examiner comment on the examples and comparative examples of record herein, which demonstrate a significant difference between the present continuous mode, compared to the pulse mode of Mehta. Thus, even if it were *prima facie* obvious to substitute a continuous mode for a pulse mode, and Appellants do not agree that there is such a case, there is no disclosure or suggestion in the prior art that the continuous mode would produce improved results.

Claim 2 is separately patentable, because the combination of Mehta and Verhaverbeke et al neither discloses nor suggests the subject matter of Claim 1, wherein the high-density film is a film necessary for said substrate and said low-density film is a film unnecessary for said substrate.

Claim 3 is separately patentable, because the combination of Mehta and Verhaverbeke et al neither discloses nor suggests the subject matter of Claim 1, wherein the low-density film includes impurities thereon or therein, and said impurities are removed together with said low-density film.

Claim 5 is separately patentable, because the combination of Mehta and Verhaverbeke et al neither discloses nor suggests the subject matter of Claim 1, wherein the substrate is a silicon substrate, said high-density film is a thermal oxide film, and said low-density film is a

natural oxide film formed on said surface of said substrate or an oxide film formed with a chemical solution on said surface of said substrate.

Claim 6 is separately patentable, because the combination of Mehta and Verhaverbeke et al neither discloses nor suggests the subject matter of Claim 1, wherein the substrate is a substrate for a semiconductor device.

Claim 7 is separately patentable, because the combination of Mehta and Verhaverbeke et al neither discloses nor suggests the subject matter of Claim 1, wherein the high-density film is formed on said substrate via a substrate layer.

Claim 8 is separately patentable, because the combination of Mehta and Verhaverbeke et al neither discloses nor suggests the subject matter of Claim 1, wherein the mixed gas is maintained at a temperature between room temperature and 200°C.

Claim 9 is separately patentable, because the combination of Mehta and Verhaverbeke et al neither discloses nor suggests the subject matter of Claim 1, wherein the mixed gas is maintained at a temperature between room temperature and 100°C.

Claim 10 is separately patentable, because the combination of Mehta and Verhaverbeke et al neither discloses nor suggests the subject matter of Claim 1, wherein the surface of said substrate is maintained at a temperature between 30°C to 50°C.

Claim 11 is separately patentable, because the combination of Mehta and Verhaverbeke et al neither discloses nor suggests the subject matter of Claim 1, wherein the mixed gas has a flow rate of from 40 to 60 L/min.

Claim 12 is separately patentable, because the combination of Mehta and Verhaverbeke et al neither discloses nor suggests the subject matter of Claim 1, wherein the a concentration of anhydrous hydrogen fluoride gas contained in said mixed gas is in a range of from 1 vol.% to 3 vol.%.

Claim 13 is separately patentable, because the combination of Mehta and Verhaverbeke et al neither discloses nor suggests the subject matter of Claim 1, wherein the a concentration of anhydrous hydrogen fluoride gas contained in said mixed gas is in a range of from 1.5 vol.% to 2 vol.%.

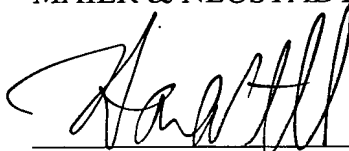
Claim 14 is separately patentable, because the combination of Mehta and Verhaverbeke et al neither discloses nor suggests a product obtained by the process according to Claim 1, wherein the high density film is a thermal oxide film, and is removed in an amount of 0 to not greater than 0.2 nm.

IX. CONCLUSION

For all the above reasons, it is respectfully requested that the above rejection be REVERSED.

Respectfully submitted,

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APPENDIX

CLAIMS ON APPEAL

1. A process for cleaning a surface of a substrate, said surface carrying thereon a high-density film and a low-density film lower in density than said high-density film in combination, which comprises continuously bringing a mixed gas comprising anhydrous hydrogen fluoride gas and a heated inert gas into contact with said surface of said substrate such that at least a portion of said low-density film is removed without impairing said high-density film beyond a tolerance, wherein the mixed gas does not contain steam.

2. A process according to claim 1, wherein said high-density film is a film necessary for said substrate and said low-density film is a film unnecessary for said substrate.

3. A process according to claim 1, wherein said low-density film includes impurities thereon or therein, and said impurities are removed together with said low-density film.

5. A process according to claim 1, wherein said substrate is a silicon substrate, said high-density film is a thermal oxide film, and said low-density film is a natural oxide film formed on said surface of said substrate or an oxide film formed with a chemical solution on said surface of said substrate.

6. A process according to claim 1, wherein said substrate is a substrate for a semiconductor device.

7. A process according to claim 6, wherein said high-density film is formed on said substrate via a substrate layer.

8. A process according to claim 1, wherein said mixed gas is maintained at a temperature between room temperature and 200°C.

9. A process according to claim 1, wherein said mixed gas is maintained at a temperature between room temperature and 100°C.

10. A process according to claim 1, wherein said surface of said substrate is maintained at a temperature between 30°C to 50°C.

11. A process according to claim 1, wherein said mixed gas has a flow rate of from 40 to 60 L/min.

12. A process according to claim 1, wherein a concentration of anhydrous hydrogen fluoride gas contained in said mixed gas is in a range of from 1 vol.% to 3 vol.%.

13. A process according to claim 1, wherein a concentration of anhydrous hydrogen fluoride gas contained in said mixed gas is in a range of from 1.5 vol.% to 2 vol.%.

14. A product obtained by the process according to Claim 1, wherein the high density film is a thermal oxide film, and is removed in an amount of 0 to not greater than 0.2 nm.